Global Tropospheric Experiment Arctic Boundary Layer Expedition 3A (ABLE 3A) Langley ASDC Data Set Document

Summary

This document provides information on data products obtained during the GTE ABLE 3A atmospheric science expedition conducted over northern Canada and Alaska during July and August 1988. The objectives of the mission were to investigate the magnitude and variability of methane emissions from the tundra ecosystem, and to elucidate factors controlling ozone production and destruction in the Arctic atmosphere. Measurements were made primarily by investigators' instruments located on the NASA Wallops Electra airborne laboratory. Also provided are a list of principal investigators and a list of publications.

This document provides information for the following four data sets:

- GTE_A3A_Elec_Chem
- GTE_A3A_Elec_Flux
- GTE_A3A_Tower
- GTE_A3A_Met_Traj

Acknowledgment

The investigators involved in the ABLE 3A mission were funded by NASA. The funded investigators, their organization and their grant, agreement or contract number were:

Area	Investigator	Organization	Grant
Aircraft	D. D. Davis	Georgia Tech	N/A
	Edward Browell	NASA Langley	N/A
	Gerald Gregory	NASA Langley	N/A
	Sherwood Rowland	U of California-Irvine	NAG-1-783
	Glen Sachse	NASA Langley	N/A
	Hanwant Singh	NASA Ames	N/A
	R. C. Harriss	U of New Hampshire	NAG-1-1014
Surface	David Fitzjarrald	State U of New York-Albany	N/A
	R. C. Harriss	U of New Hampshire	NAG-1-1014
	Steven Wofsy	Harvard	N/A

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1. Collection Overview

a. Collection Contents

Aircraft data sets are available for each investigation for each flight. Ground-based data are usually available on a daily basis. Airborne measurements were typically obtained at constant altitude during the transit flights (i.e. "survey" flights), and over multiple altitudes during flights from the intensive sites. Flight missions were conducted during ABLE 3A from July through August 1988. Section 4.b lists the flight dates. The duration, altitude range, ascent and descent rate, and flight path for each mission varied depending on mission objectives and environmental conditions. Ground-based measurements are discussed in Harriss et al., [1992]. The automated ground sites provided daily measurements during the time frame when airborne measurements were being made and weekly averaged samples before and after. Further information about the measurement region and time frame may be found in the Journal of Geophysical Research, Vol. 97, No. D15, 16383-16394, October 30, 1992.

Data Set Introduction

This data set contains all of Electra aircraft data, trajectory and ground station data submitted to the GTE data archive by the ABLE 3A investigators listed in Section 1.d. Included are the atmospheric chemistry, meteorological and navigational data recorded aboard the NASA Wallops Electra airborne laboratory and data obtained from surface level sites. Merged data sets are not included in this archive but can be found at the GTE data archive.

Summary of Parameters

The atmospheric species and other parameters measured are listed in Section 4.c. Also listed for each are the name and affiliation of the principal investigator.

b. Related Data Collections

ABLE 3A investigators have individually reported the results of their investigations in the Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1992.

There are data sets available from the Langley ASDC for 13 other GTE missions conducted from 1983 to 2001. See the GTE home page and/or ASDC GTE Data and Information for a description of the available data.

c. Title of Investigation

Global Tropospheric Experiment Arctic Boundary Layer Expedition 3A (ABLE 3A)

d. Investigator Name and Title

If the person is known to be retired, deceased or no longer at the organization originally responsible for the investigation, it is noted and the contact information may be omitted. The contact information provided was current during the mission, but may no longer be current.

Electra Investigators

Investigator Area	Investigator Information
Airborne Meteorological/Position Data	John D. Barrick MS 483 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-5831 Fax: 757-864-5841 E-mail: john.d.barrick@nasa.gov

Nitric Oxide, Nitrogen Dioxide, NO_Y	John Bradshaw (Principal Investigator, Deceased) Scott Sandholm (Co-Investigator) Georgia Institute of Technology Earth and Atmospheric Sciences Baker Building, Room 107 923 Dalney Street Atlanta GA 30332-0340 Telephone: 404-894-3895/3824 Fax: 404-894-5073 E-mail: ss27@prism.gatech.edu
Aerosols and Ozone Profiles	Edward V. Browell Mail Stop 401A NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1273 Fax: 757-864-7790 E-mail: edward.v.browell@nasa.gov
In-situ Ozone and Aerosol Size Distribution	Gerald L. Gregory (retired) NASA Langley Research Center
Radon	E. B. Pereira Instituto de Pesquisas Espaciais C.P. 515 12200-Sao Jose dos Campos - SP Brazil Telephone: 55-123-229977 Fax: 55-123-218743
Turbulent Flux of CO, O_3, H_2O, CH_4	John Ritter (no longer at LaRC) Kenneth Lee Thornhill (Current) MS 483 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-4278 Fax: 757-864-5841 E-mail: kenneth.l.thornhill@nasa.gov
Non-methane Hydrocarbons (to C_6)	F. Sherwood Roland University of California-Irvine Department of Chemistry Irvine, CA 92717 Telephone: 714-856-6016 Fax: 714-725-2905 E-mail: rowland@uci.edu
Carbon Monoxide, Methane	Glen W. Sachse MS 472 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1566 Fax: 757-864-8818 E-mail: glen.w.sachse@nasa.gov
PAN, PPN, C_2Cl_4, CH_3ONO_2	Hanwant Singh NASA Ames Research Center Singh Group Mail Stop 245-5 Moffett Field CA 94035 Telephone: 415-604-6769 Fax: 415-604-3265 E-mail: hanwant.b.singh@nasa.gov
Aerosol Composition, Nitric Acid, Organic Acids	Robert W. Talbot University of New Hampshire Institute of Earth, Oceans, Space Morse Hall Complex Systems Research Center Durham NH 03820 Telephone: 603-862-1546 Fax: 603-862-0188 E-mail: rwt@christa.unh.edu
Carbon Dioxide	S. C. Wofsy Center for Earth and Planetary Physics Pierce Hall

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Ground-based Measurements Investigators

Investigator Area	Investigator Information
Heat, Humidity and Momentum Budgets and CO_2	D. R. Fitzjarrald Atmospheric Sciences Research Center SUNY-Albany 100 Fuller Road Albany NY 12005 Telephone: 518-442-3838 Fax: 518-442-3867
CH_4 Flux	P. Kebabian Center for Chemical and Environmental Physics Aerodyne Research, Inc. Billerica MA 01821 Telephone: 617-663-9500
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BREW Program (Biospheric Research of Emissions from Wetlands)

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  Darling Marine Center
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  Walpole ME 04573
  Telephone: 207-563-3146
- D. S. Bartlett (no longer at NASA LaRC)
  NASA Langley Research Center
- R. C. Harriss (no longer at NASA LaRC)
  NASA Langley Research Center

e. Technical Contact(s)

The following persons have more specialized knowledge about the data in the data sets or in their field or general knowledge about the mission, its execution and the data sets.

Investigator or Knowledge Area	Investigator and Contact Information
Nitric Oxide, Nitrogen Dioxide, NO_Y aboard the Electra	D. D. Davis Georgia Institute of Technology School of Earth and Atmospheric Sciences

	Room 108 221 Bobby Dodd Way Atlanta GA 30332-0340 Telephone: 404-894-9565 Fax: 404-894-1993 E-mail: dd16@prism.gatech.edu	
Non-methane hydrocarbon measurements aboard the Electra	Donald Blake University of California-Irvine Department of chemistry Irvine CA 92717 Telephone: 714-856-4195 Fax: 714-725-2905 E-mail: drblake@uci.edu	
Aerosol Composition, Nitric Acid, Organic Acids	R. C. Harriss Institute for the Study of Earth, Oceans and Space Science and Engineering Research Center University of New Hampshire 929 College Road Durham NH Telephone: 603-862-3875	
ABLE 3A Mission Scientist and Associate Mission Scientist	R. C. Harriss (See prior listing above)	S. C. Wofsy (See prior listing above)
ABLE 3A Program Manager	Robert J. McNeal (retired) NASA Headquarters	
ABLE 3A Project Manager	James M. Hoell, Jr. (retired) NASA Langley Research Center	
ABLE 3AMission Meteorologist	Mark Shipham (no longer at LaRC) NASA Langley Research Center	
ABLE 3A Expedition Manager	Richard J. Bendura (retired) NASA Langley Research Center	
Electra Aircraft Operations and Systems Integration	Roger Navarro (retired) NASA Wallops	Wallops Flight Facility Aircraft Office NASA Wallops Flight Facility Wallops Island VA 23337-5099 Telephone: 757-824-1529
Project Coordinator	Helen Ann Thompson (no longer at ST Systems)	
ABLE 3A Data Products Manager	Joseph W. Drewry (retired) NASA Langley Research Center	

2. APPLICATIONS AND DERIVATION

Potential usage and applications of the described data sets can be seen in the articles that comprise the Journal of Geophysical Research ABLE 3A Special Section (Vol. 97, No. D15 October 30, 1992) and the 1989 Spring AGU Meeting.

a. Calculated Variables

For convenience of the users, the calculated variables below are provided.

Mach Number, M:

$$M = \sqrt{5 * \left[\left(\frac{Q_c}{P_s} + 1 \right)^{(2/7)} - 1 \right]}$$

M = Mach Number
Ps = Static Pressure
Qc = Differential Pressure

Static Air Temperature, Ts:

$$T_S(°K) = \frac{T_T}{\left[1 + M^2 * \left(\frac{\gamma - 1}{2}\right)\right]}$$

T_S = Static Air Temperature (°K)
T_T = Total Air Temperature (°K)
γ = 1.4, ratio of specific heat of air at constant pressure and volume

True Air Speed, TAS:

$$TAS(kts) = M * a = M * 38.96695 * \sqrt{T_S}$$

TAS = True Air Speed (knots)
T_S = Static Air Temperature (°K)
M = Mach Number
a = Speed of Sound

Potential Temperature, θ:

$$\theta(°K) = T_S * \left(\frac{1000}{P_S}\right)^{0.2857142}$$

θ = Potential Temperature (°K)
T_S = Static Air Temperature (°K)
Ps = Static Pressure (mb)

Vapor Pressure, e :

e_{water} (mb) = [1.0007 + (3.46 * 10^{-6} * P_S)] * 6.1121* EXP[17.502 * T/(240.97 + T)]

e_{ice} (mb) = [1.0003 + (4.18 * 10^{-6} * P_S)] * 6.1115* EXP[22.452 * T/(272.55 + T)]

e = Partial Pressure of Water Vapor (mb)
P_S = Static Pressure (mb)
T = Static Air Temperature (°C) for Saturation Vapor Pressure
or
T = Dew/Frost Point (°C) for Partial Pressure of Water Vapor

Note:

1. ProjDP of zero or greater should be used to derive the partial pressure of water vapor w.r.t water (e_{water}) and the ProjDP less than zero should be used to derive the partial pressure of water vapor w.r.t ice (e_{ice}).

2. StatTempDegC and ProjDP parameters recorded in the P-3B data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively.

3. TSDEGC and ProjDP parameters recorded in the DC-8 data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively. Also notice in the DC-8 data set there is a redundant static air temperature measurement, TSCALC, which is calculated by DADS. Although TSDEGC and TSCALC track closely they can diverge by ? 1° at the low and high ends of the measurement range.

Specific Humidity, q:

$$q(g/kg) = \frac{0.622 * 10^3 * e}{(P_S - 0.377e)} \qquad q(ppmw) = \frac{0.622 * 10^6 * e}{(P_S - 0.377e)}$$

Mixing Ratio, r:

$$r(g/kg) = \frac{0.622 * 10^3 * e}{(P_S - e)} \qquad r(ppmw) = \frac{0.622 * 10^6 * e}{(P_S - e)}$$

Note:
ppmv = 1.608 * ppmw
ppmw = 0.622 * ppmv

Relative Humidity, %:

w.r.t. water,

$$RH_{water} = \frac{e_{water}}{e_{S_{water}}} * 100$$

w.r.t. ice,

$$RH_{ice} = \frac{e_{ice}}{e_{S_{ice}}} * 100$$

b. Graphs and Plots:

Interested readers should see the Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1992, and documents referenced therein, for plots and the results of analysis of data.

3. DATA DESCRIPTION AND ACCESS

a. Format

See the GTE Data Format Document.

b. Data Organization

Granularity

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary. Aircraft data sets are available for each investigation for each flight. Surface level data are available on a daily basis.

c. Data Collection Status and Plans

This data set contains all of Electra aircraft data, trajectory and ground station data submitted to the GTE data archive by the ABLE 3A investigators listed in Section 1.d. Included are the atmospheric chemistry, meteorological and navigational data recorded aboard the NASA Wallops Electra airborne laboratory and data obtained from surface level sites. Merged data sets are not included in this archive but can be found at the GTE data archive. No additional data products relevant to ABLE 3A are anticipated.

d. Data Access

This data is available online through the GTE Data and Information table or on a CDROM via the LaRC ASDC and from the GTE data archive.

e. Data Archive Center

The Atmospheric Science Data Center at NASA's Langley Research Center.

Contacts for Data Center or Data Access Information:

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E-mail: support-asdc@earthdata.nasa.gov
Internet: http://eosweb.larc.nasa.gov

f. How to Cite the Data Collection

Publication of a portion(s) of the data archive should acknowledge the principal investigator(s) responsible for the data by referencing the appropriate manuscript in the Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1992.

4. DATA CHARACTERISTICS:

a. Study Area

Airborne measurements were made over northern Canada and Alaska. A more detailed description of the surface level environmental characteristics for the experiment region is provided in the individual papers for each investigation included in the Journal of Geophysical

Research, Vol. 97, No. D15, October 30, 1992. Additional information may be found in other publications authored by the principal investigators or on the GTE home page.

Spatial Coverage

Flight missions were conducted during July and August, 1988. Also shown are the takeoff and landing sites. The duration, altitude range, assent and descent rate, and flight path of each mission varied depending on mission objective and environmental conditions. The nominal air speed ranged from 275 knots (approximately 316 mph) at 6.13 km altitude to 197 knots (approximately 227 mph) at 0.123 km.

Data Set Name	Min Lat	Max Lat	Min Lon	Max Lon
GTE_A3A_Elec_Chem	38.0N	80.9N	-75.5E	-168.0E
GTE_A3A_Elec_Flux	60.4N	70.5N	-154.8E	-164.2E
GTE_A3A_Tower	61.0N	61.0N	162.5W	162.5W
GTE_A3A_Met_Traj	38.0N	80.9N	-75.5E	-168.0E

Spatial and Temporal Resolution

Resolution varies for each measurement. See the individual headers associated with each data file for specific information.

Grid Description

No data gridding or binning of data to a geographic grid occurred during data processing.

b. Temporal Coverage

ABLE 3A aircraft missions were conducted from July 7 through August 17, 1988. The dates and times for each mission are given in Harriss et al., [1992]. Ground site measurements were obtained from (date) to (date).

Data Set Name	Begin Date	End Date
GTE_A3A_Elec_Chem	7/7/88	8/17/88
GTE_A3A_Elec_Flux	7/18/88	8/9/88
GTE_A3A_Tower	7/10/88	8/13/88
GTE_A3A_Met_Traj	7/5/88	8/17/88

c. Parameter or Variable

Not all of the parameters are in each data set granule. Also, the ranges vary between data sets and between granules within each data set. Species measured are given in Harriss et al., [1992]

Parameter Description

The variables measured are standard atmospheric chemical and meteorological species requiring no further elaboration here.

Unit of Measurement

The units of measure vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1988.

Parameter Source

The instruments used in making the measurements are listed in the individual papers included in the ABLE 3A Special Section in the Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1992.

Parameter Range

The ranges of data vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1992.

Sample Data Record

The GTE Data Format Document contains examples of each data set type.

d. Error Sources

The sources of error vary depending on species and measurement environment and are addressed in the papers included in the ABLE 3A special issue of the Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1992, and/or papers referenced in that publication and readme files and/or header records associated with each data file.

5. USAGE GUIDANCE

a. **Known Problems with the Data**

None reported for the current archive version. See the readme files and header records included with each data set for information provided by the responsible investigator.

b. **Future Modifications and Plans**

The data sets submitted to the ASDC are considered final and no further updates are planned. However, modifications will be considered if requested by the investigators or otherwise justified.

6. ACQUISITION MATERIALS AND METHODS

Details of data acquisition and materials are addressed in the Journal of Geophysical Research ABLE 3A Special Section (Vol.97, No. D15, October 30, 1992) and the 1989 AGU Spring Meeting.

7. REFERENCES

AGU Spring Meeting, Baltimore, MD, 7-12 May 1989.

ABLE 3A Special Section, Journal of Geophysical Research, Vol. 97, No. D15, October 30, 1992.

GTE Bibliography

Harriss, R. C., S. C. Wofsy, D. S. Bartlett, M. C. Shipham, D. J. Jacob, J. M. Hoell, , R. J. Bendura, J. W. Drewry, R. J. McNeal, R. L. Navarro, R. N. Gidge, and V. E. Rabine,, The Arctic Boundary Layer Expedition (ABLE 3A): July-August 1988, J. Geophys. Res., Vol. 97, No. D15, 16383-16394, 30 October, 1992.

8. ACRONYMS

ABLE 3A - Arctic Boundary Layer Expedition
AGU - American Geophysical Union
ASDC - Atmospheric Science Data Center
BREW - Biospheric Research of emissions from Wetlands
DADS - Data Acquisition and Display System
EOSDIS - Earth Observing System Distributed Information System
GTE - Global Tropospheric Experiment
IMS - Information Management System
LaRC - NASA Langley Research Center
NASA - National Aeronautics and Space Administration
ProjDP - Project Dew Point

TSCALC - Static temperature, calculated by DADS
TSDEGC - Static temperature, measured directly, in Celsius

9. Document Information:

- **Creation Date:** November 2003
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- **Review Date:**
- **Identification:**
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